Implantable Piezoelectric Generators

National Aeronautics and Space Administration

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Intro to Piezoelectrics

Piezoelectrics are materials that respond to stimulation according to the piezoelectric effect. When a mechanical force or temperature gradient is applied to the material, the capacitive quality produces a voltage across the material.

Piezoelectric stacks are layers of a type of this material, in this case a ceramic, which are electrically connected in parallel and physically connected in series.

Project Background

Piezoelectric generators are currently being studied in a variety of energy harvesting situations. The goal of this project is to replace external, rechargeable or replaceable power supplies for implanted electronic medical devices with implanted piezoelectric stack generators. These will convert the force from muscle twitches into electricity then used to power the devices. Preliminary animal experiments have shown that this is a viable method of powering internal electrical devices[2].

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Experimental Setup

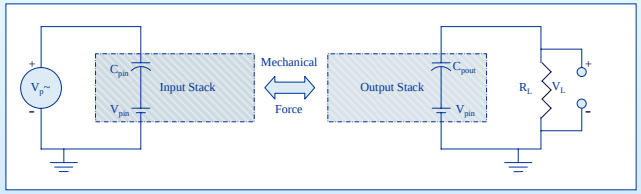

Figure 1. Circuit diagram for configuration shown in Figure 2.

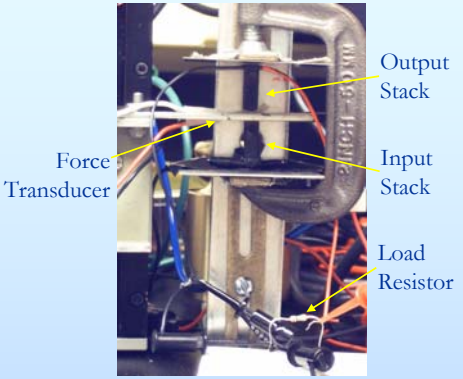

Figure 2. Photograph of experimental setup.

Current Work

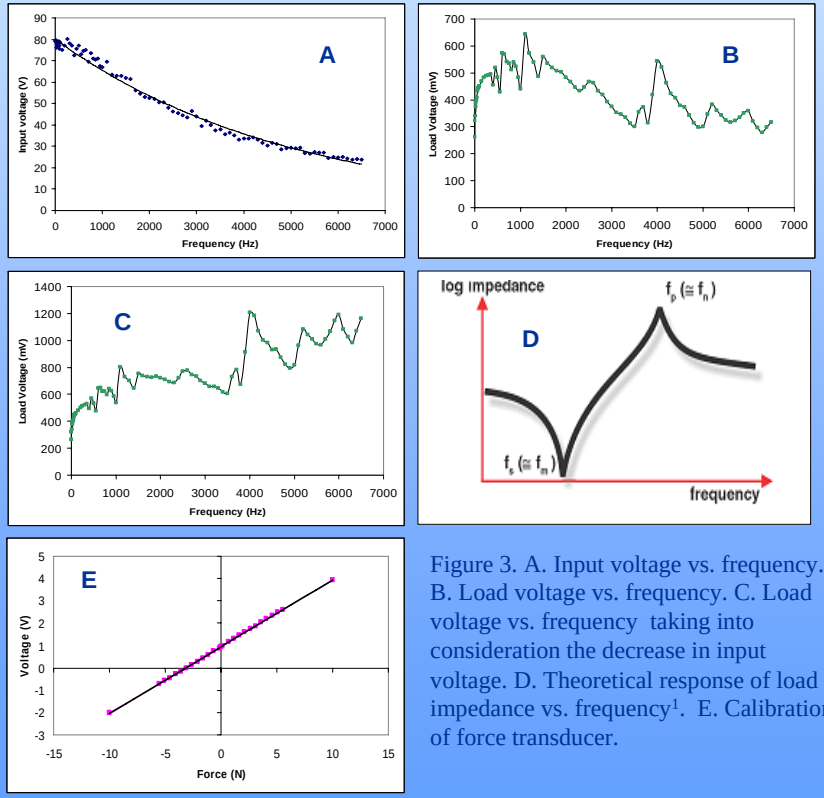

Figure 3. A. Input voltage vs. frequency. B. Load voltage vs. frequency. C. Load voltage vs. frequency taking into consideration the decrease in input voltage. D. Theoretical response of load impedance vs. frequency[1]. E. Calibration of force transducer.

Future Work

- Use force transducer to better characterize load voltage and determine resonance frequencies.
- Connect a stack to an EPAD energy module which will collect and store the energy produced
- Analyze characteristics of the EPAD module
- Determine spring constants for springs to be used in muscle twitch experiments

References

1. APC International, Ltd. *Determining Resonance Frequency.* www.americanpiezo.com/piezo_theory/resonance_frequency.html

2. Lewandowski, B.E., K.L. Kilgore, and K.J. Gustafson. *Design Considerations for an Implantable, Muscle Powered Piezoelectric System for Generating Electrical Power.* Annals of Biomedical Engineering, 2007. 35(1): p.631-641.